

**BIOLOGY AND SEASONAL HISTORY OF
RHOPALUS (BRACHYCARENUS) TIGRINUS, WITH
DESCRIPTIONS OF IMMATURE STAGES
(HETEROPTERA: RHOPALIDAE)**

A. G. WHEELER, JR. AND E. RICHARD HOEBEKE

Bureau of Plant Industry, Pennsylvania Department of Agriculture,
Harrisburg, Pennsylvania 17110; and
Department of Entomology, Cornell University, Ithaca, New York 14853

Abstract.—Seasonal history and habits are presented for *Rhopalus (Brachycarenum) tigrinus* Schilling, based mainly on observations made in Pennsylvania during 1980-1984. Nymphs and adults of this multivoltine Palearctic rhopalid recently recorded in eastern North America feed on reproductive structures of crucifers. Developmental times of the immature stages and data on pre mating period, fecundity, and longevity are given. The egg and nymphal stages are described, and scanning electron photomicrographs are provided for the egg and instars I-II and V.

Rhopalus (Brachycarenum) tigrinus Schilling, a scentless plant bug (Rhopalidae), is the widest ranging species of the genus (Göllner-Scheiding, 1983). Its natural range includes much of the Palearctic region, including Afghanistan and Pakistan but not the British Isles or Japan (Göllner-Scheiding, 1978; Ahmad, 1980). First detected in North America in Cumberland Co., New Jersey (Hoebeke, 1977), this immigrant species is now known from an additional county in New Jersey (Camden); Long Island, New York; Philadelphia and near Harrisburg, Pennsylvania (Hoebeke and Wheeler, 1982); and Baltimore, Maryland (Wheeler, 1984). Recent collections by AGW in 1987 also place it in Kent Co., Maryland (near Massey) and in Atlantic Co., New Jersey (Hammonton). Hoebeke and Wheeler (1982) provided a diagnosis, key, and illustrations allowing *R. tigrinus* to be distinguished from adults of the 15 other rhopalid species known to occur in eastern North America and recorded several crucifers (Cruciferae = Brassicaceae) as host plants. Here, we give notes on seasonal history, report on laboratory rearing, and describe and illustrate the immature stages.

MATERIALS AND METHODS

Field observations were made irregularly during 1980-1981 and 1984 on a population of *R. tigrinus* at the Enola railroad yards near Harrisburg, Pennsylvania. The sketch of seasonal history presented also is based on observations and collections made during 1979-1984 at Philadelphia; Baltimore; Medford and Yaphank, Long Island, New York; and Camden and Vineland, New Jersey.

Data on duration of immature stages, pre mating and pre oviposition times, fecundity, and longevity are based on laboratory rearing of *R. tigrinus* at Ithaca, New York, and Harrisburg, Pennsylvania; both colonies originated from adults (4 male, 8 female) collected at Vineland, New Jersey, during 26-28 May 1979.

At Ithaca, two pairs were placed in individual large plastic boxes (26.5 cm × 19

Table 1. Duration (in days) of immature stages of *Rhopalus tigrinus* reared in laboratory at Ithaca, New York (22–26°C) and Harrisburg, Pennsylvania (20–22°C); Harrisburg data are given in parentheses.

Stage	No. of observations	Range	Mean \pm SD	Cumulative mean age
Egg	142 (14)	5–18 (8–9)	9.02 \pm 0.02 (8.64 \pm 0.04)	9.02 (8.64)
Nymphal stages				
I	47 (12)	2–9 (3–6)	3.91 \pm 0.04 (4.42 \pm 0.08)	12.93 (13.06)
II	38 (11)	1–5 (2–5)	2.37 \pm 0.02 (2.82 \pm 0.09)	15.30 (15.88)
III	34 (8)	1–3 (2–6)	2.06 \pm 0.02 (3.38 \pm 0.15)	17.36 (19.26)
IV	28 (4)	2–5 (3–6)	3.39 \pm 0.03 (3.75 \pm 0.38)	20.75 (23.01)
V	15 (— ^a)	3–8 (—)	4.67 \pm 0.08 (—)	25.42 (—)

^a —, No observations.

cm \times 10 cm), and single females were set up in two smaller plastic containers (8 cm diam., 2 cm deep). Both types of rearing containers were provided a water source and a sprig of shepherd's-purse, *Capsella bursa-pastoris* L. (Cruciferae), bearing flowers and fruits. They were maintained at room temperature (22–26°C) under natural photoperiod (window light). Host material was renewed every 2–3 days. Eggs deposited in rearing containers were assigned numbers, observed for hatching, and the resulting nymphs checked daily for ecdysis. Observations continued until three generations were completed (mid-September). The last generation was reared on peppergrass, *Lepidium virginicum* L. (Cruciferae).

At Harrisburg, two pairs and two females were set up in a manner similar to that used at Ithaca except that cultures were kept at 20–22°C and a 12-hr photoperiod. The first through fourth stadia are based on few observations owing to difficulties in rearing this rhopalid. Because all fifth instars died before molting, the fifth stadium was not determined.

BIOLOGY

Laboratory observations. From eggs laid approximately the same time, males emerged slightly before females (usually only 1 day or less). After a premating period of 3–5 days ($N = 2$), pairing occurred quickly without apparent courtship ritual. Pairs assumed an end-to-end position that is typical for rhopalids (e.g., Woodward, 1952; Wheeler, 1977; Paskewitz and McPherson, 1983) and usually remained *in copula* for several hours. Multiple matings (3–7 times) were common for the three pairs observed. After a 2-day preoviposition period ($N = 2$), eggs were deposited singly or in small clusters on host fruits, or on surfaces of the rearing containers. The fecundity of 2 virgin females averaged 101 (range 73–132); that of 4 field-collected, probably nonvirgin females averaged 86 (range 49–159). Eggs, which are pale yellow-orange when deposited, begin to darken within 2–3 days; by the fifth or sixth day they are dark brown to black, and the reddish eyes and abdominal segmentation can be seen through the chorion. By day 7 the sides become noticeably sunken, eye pigmentation is well defined, and the bristlelike setae of the nymphs are readily visible. Table 1 shows an average incubation period of about 9 days, although 6–8 days was typical

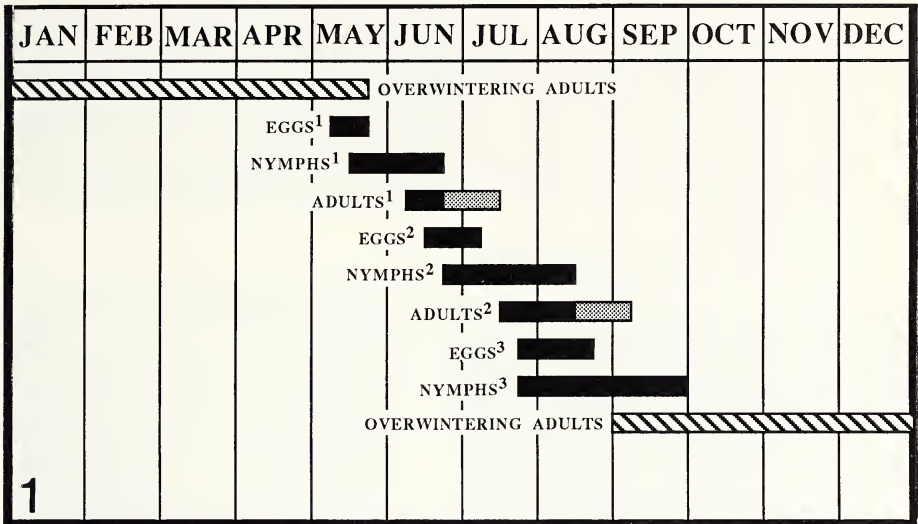


Fig. 1. Proposed seasonal occurrence of *Rhopalus (Brachycarenum) tigrinus* in eastern North America based on field and laboratory observations. [Superscript numbers refer to generations (i.e., 1 = 1st generation, etc.); stippled areas after "ADULTS 1 and 2" refer to periods of probable adult longevity, but specimens not actually observed.]

of the first two generations reared at room temperature and 10–12 days for the third generation.

Nymphs fed on reproductive structures of the crucifers, especially the fruits (siliques). The second and third stadia were the shortest, with total development time averaging 25.4 days (Table 1). Just as the incubation period was greater for the third compared to the first or second generation, the developmental period for first-stage nymphs was considerably longer in the third generation (5–9 days vs. 2–4 days).

Adults also fed on the crucifer fruits. The longevity of 2 first generation males observed was 10 and 13 days; that of 2 females, 14 and 26 days.

Field studies. Although *Rhopalus tigrinus* was sampled only at irregular intervals, our observations on development of field populations corresponded well with data obtained from the rearing of three generations in the laboratory. The phenological sketch (Fig. 1) that follows is based on field data, with the number of generations extrapolated from laboratory observations.

In the Palearctic region, adults of *R. tigrinus* are known to overwinter (Dupuis, 1953). Kiritchenko (1951) recorded nearly 100 adults hibernating in nests of several bird species. In Pennsylvania we swept an adult from crucifers as early as the first week of May and collected several overwintered adults, including mating pairs, during late May. Adults collected on 4 June at Philadelphia probably also were overwintered individuals. Teneral adults and instars II–V of a first generation were present in New Jersey during mid-June. *Capsella bursa-pastoris* was the most common early-season host; adults only were taken on other crucifers: *Arabidopsis thaliana* (L.), *Sisymbrium altissimum* L., and *Thlaspi perfoliatum* L. Adults and nymphs of a second generation

were observed at Baltimore during mid-July and early August; eggs and instars I-V of this generation were found at Philadelphia in mid- and late July. Adults and nymphs of all stages collected at Philadelphia in early September are believed to represent a third brood; these adults were not observed to mate or oviposit in the laboratory. Three adults and one third instar taken at Harrisburg on 20 September probably also belonged to this generation. Second and third generations developed on *Lepidium virginicum*, the only native plant among the known North American hosts of *R. tigrinus*.

In North America this rhopalid appears to be a crucifer specialist and the only member of the family known to feed on plants of the mustard family (see Schaefer and Chopra, 1982 and Schaefer and Mitchell, 1983 for food plants of world Rhopalidae). Stichel (1960) reported that *R. tigrinus* feeds on several crucifers in Europe, Popov (1965) listed it from *Artemisia* (Compositae) and Labiatae, Kerzhner (1967) characterized it as a "general feeder" that seems to prefer Cruciferae, and Lipa et al. (1977) reported its collection from numerous crucifers in central Europe. A preference for legumes (Gulde, 1921) and chenopods (Wagner, 1966) has been noted in the European literature, but occurrences on noncruciferous plants may be "sitting records" rather than actual hosts. We doubt whether *R. tigrinus* is a general feeder in the Old World, but the possibility of its developing on plants other than crucifers should not be eliminated. As Fox and Morrow (1981) stressed, specialization may be a local phenomenon of a population, with the species showing a wider host spectrum throughout its geographic range.

DESCRIPTION OF IMMATURE STAGES

Descriptions of the egg and nymphal instars are modified after the format and phrasing presented in Yonke and Medler (1969), Yonke and Walker (1970), Paskewitz and McPherson (1983), and Wheeler and Miller (1983). Puchkov and Puchkova (1956) provided illustrations of the egg and third-instar nymph of *R. tigrinus*, and also measurements of the nymphal stages. Herein, we provide scanning electron micrographs of the egg, and first-, second-, and fifth-instar nymphs of *R. tigrinus*.

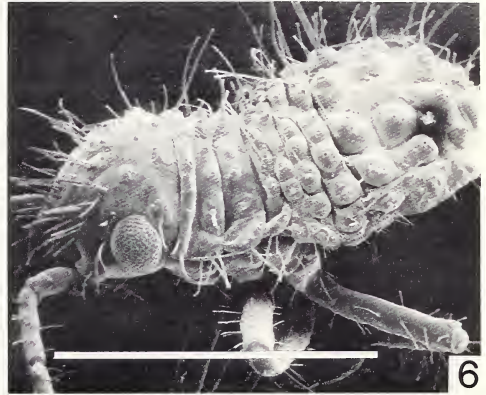
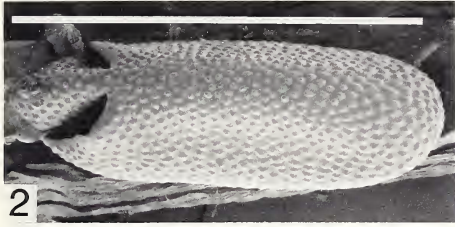
EGG (in alcohol, N = 10) (Figs. 2-4). Elongate-oval, with slight indentation on either side of median longitudinal ridge (Figs. 2, 3). Pale yellow-orange shortly after deposition, darkening significantly during incubation. Two raised, turret-shaped, aero-micropylar processes present, one situated near ventral rim of pseudopericulum and one below it (Figs. 3, 4). Chorionic surface, including pseudopericular cap, rugose, covered with numerous raised, circular projections (Fig. 2).

Length: 1.10 mm (range 1.10-1.15). Width: 0.38 mm (range 0.35-0.40).

Egg attached to host plant surface by adhesive along middle of ventral side, lacking short ventral attachment stalk characteristic of most rhopalid species (Southwood, 1956; Cobben, 1968).

Gross structure of the egg of *Rhopalus (Brachycarenum) tigrinus* is similar to that described for other Rhopalidae by Stokes (1950), Southwood (1956), Yonke and Walker (1970) and Wheeler and Miller (1983).

FIFTH INSTAR (in alcohol, N = 10) (Fig. 7). Dorsum of head, thorax, and abdomen moderately densely setose, with long, bristlelike setae arising from minute papillae and chalazae. Chalazae of mesotergum and abdominal terga multisetiferous,



Figs. 2–6. Egg and nymphal stages of *Rhopalus (Brachycarenum) tigrinus*. 2. Hatched egg, dorsolateral aspect. 3–4. Schematic representation of dorsal (3) and lateral (4) aspects of the egg showing position of 2 aero-micropylar processes, pseudopercular cap, and broad mid-longitudinal ridge of dorsum. 5. First instar, frontal dorsal aspect. 6. Second instar, dorsolateral aspect. All scale bars = 1 mm.

arranged in transverse rows. Body relatively pyriform, slightly dorsoventrally flattened.

Color variable among live specimens but generally brown-green with various dark infuscations, and dark spotting at base of setae on antennae and legs; color fading to pale white or yellow in alcohol-preserved specimens. Apices of antennal segments II and III, entire segment IV, some dorsal aspects of head, calli, and portions of posterior margin of pronotum, mesonotum, metanotal wing pads, and apices of mesonotal wing pads infuscated. Dark spots of legs sometimes coalescing to form bands, especially on femora. Eyes reddish. Dorsal and ventral surfaces of head, thorax, and abdomen spotted with red; collectively, in form of transverse striping on abdominal terga. Chalazae of abdominal terga heavily sclerotized, dark brown to black. Dorsal and ventral surfaces of body and appendages moderately densely covered with mixture of black and pale setae; setae of prominent abdominal chalazae black, those of general body surfaces white with some darker banding.

Length: 4.57 mm (range 4.10–6.40). Pronotal length: 0.61 mm (range 0.55–0.68).

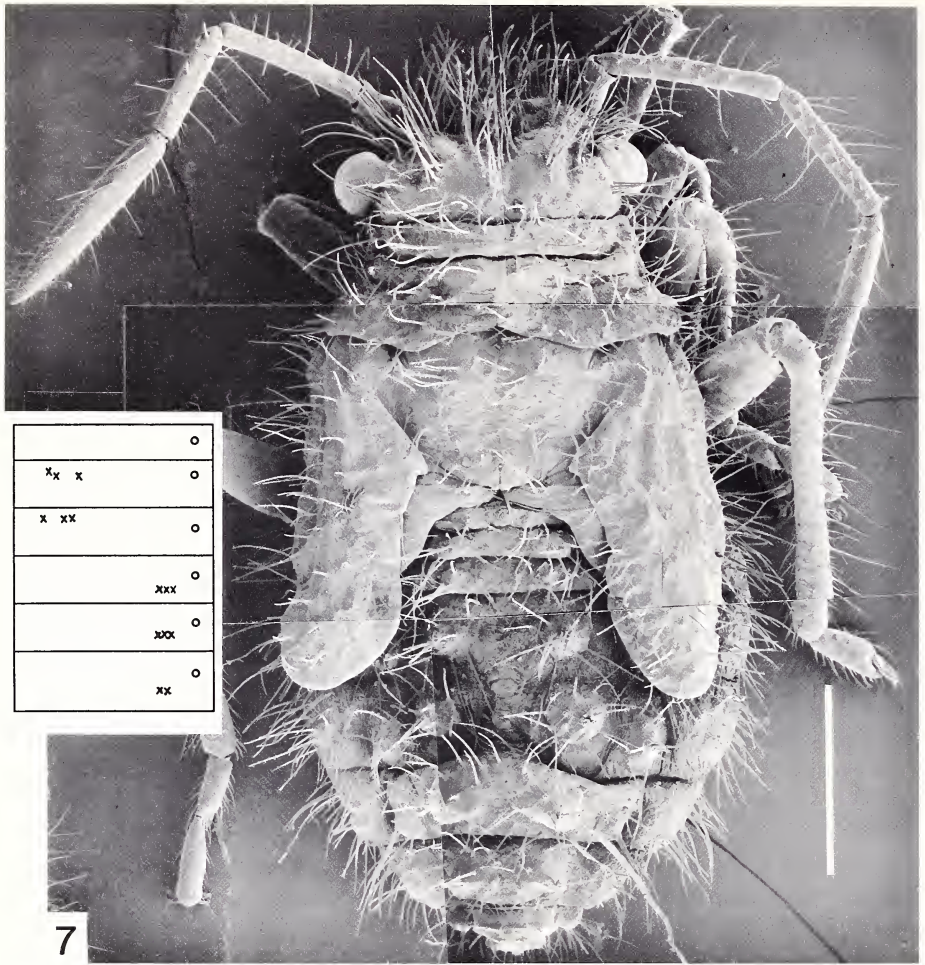


Fig. 7. Fifth instar of *Rhopalus (Brachycarenum) tigrinus*, dorsal aspect, and (insert) trichobothrial pattern of abdominal sterna II–VII (x = position of trichobothria, and o = position of spiracles). Scale bar = 1 mm.

Basal pronotal width: 1.50 mm (range 1.30–1.65). Outer ocular width: 1.38 mm (range 1.30–1.50). Interocular width: 0.88 mm (range 0.83–0.98). Antennal lengths, I: 0.46 mm (range 0.43–0.50); II: 0.75 mm (range 0.70–0.80); III: 0.63 mm (range 0.60–0.68); IV: 0.98 mm (range 0.95–1.05).

Head. Antennal segments cylindrical; segment I short, broad; segments II–IV elongate, covered with long, erect (black and pale) setae, II slightly longer than III; segment IV apically pointed, with apical $\frac{1}{2}$, between long setae, densely covered with minute setulae. Jugum extending to at least $\frac{2}{3}$ length of tylus; both densely covered with long, bristlelike, black setae; antenniferous tubercle lacking. Labium extending to

middle of mesocoxae. Eyes large, prominent; dorsal surface of frons and occiput densely covered with long, black, bristlelike setae.

Thorax. Pronotum roughly trapezoidal, transverse, surface moderately densely covered with long, bristlelike setae; calli present, crescent-shaped; meso- and meta-thoracic wing pads extending to abdominal segment IV or V. Mesonotum with 2 prominent chalazae on either side of median line. Legs moderately densely covered with long, erect setae. Protibia with 3 black, strong setae in row on outer surface. Mesotibia with 1 black, strong seta at basal $\frac{1}{3}$ of outer surface. Metatibia with 1 black, strong seta at middle of outer surface. Tarsi 2-segmented; pretarsi with 2 claws and 2 prominent pulvilli.

Abdomen. Four prominent chalazae on disc of terga III–VII, each bearing numerous long, bristlelike, black setae. Subdorsal pair of chalazae of terga I–V broadly separated along midline; width between chalazae gradually increasing in each succeeding segment, width broadest on tergum V. Pair of subdorsal chalazae of tergum VII nearly confluent along midline. Ventral segments moderately densely setose, with short, erect, pale setae. Pattern of trichobothria on ventral segments II–VII as in Fig. 7 (see insert).

Tergum I with median papilla and single transverse row of setae on either side, setae nearest midline on slightly raised tubercle. Two dorsal abdominal scent gland openings present, one between terga IV–V and one between terga V–VI; tergum V constricted at midline. Dorsum of terga VIII and IX with dark sclerotized plate.

FOURTH INSTAR (in alcohol, N = 5). Form and coloration as in fifth instar; chalazae of abdominal terga IV–VII and dorsal plates of terga VIII and IX strongly infuscated. Reddish spots of abdomen coalescing, forming transverse stripes. Wing pads reaching abdominal segment III.

Length: 3.53 mm (range 2.88–4.25). Pronotal length: 0.37 mm (range 0.29–0.54). Basal pronotal width: 1.10 mm (range 1.08–1.15). Outer ocular width: 1.05 mm (range 1.00–1.10). Interocular width: 0.67 mm (range 0.65–0.72). Antennal length, I: 0.36 mm (range 0.36); II: 0.52 mm (range 0.50–0.54); III: 0.47 mm (range 0.45–0.50); IV: 0.71 mm (range 0.65–0.76).

THIRD INSTAR (in alcohol, N = 5). Coloration similar to fourth instar; wing pads weakly developed, appearing as small lateral lobes.

Length: 2.57 mm (range 2.34–2.88). Pronotal length: 0.20 mm (range 0.18–0.25). Basal pronotal width: 0.84 mm (range 0.79–0.90). Outer ocular width: 0.86 mm (range 0.79–0.88). Interocular width: 0.55 mm (range 0.54–0.58). Antennal length, I: 0.25 mm (range 0.23–0.27); II: 0.45 mm (range 0.43–0.47); III: 0.37 mm (range 0.36–0.39); IV: 0.55 mm (range 0.54–0.57).

SECOND INSTAR (in alcohol, N = 2) (Fig. 6). Body pyriform; nearly pale, eyes sometimes reddish. Black, bristlelike setae of head, thorax and of chalazae of abdominal terga IV–VII prominent. No wing pad development.

Length: 1.57 mm (range 1.46–1.68). Pronotal length: 0.12 mm (range 0.11–0.13). Basal pronotal width: 0.56 mm (range 0.53–0.58). Outer ocular width: 0.53 mm (range 0.47–0.59). Interocular width: 0.36 mm (range 0.31–0.40). Antennal length, I: 0.14 mm (range 0.12–0.16); II: 0.28 mm (range 0.24–0.33); III: 0.28 mm (range 0.25–0.32); IV: 0.39 mm (range 0.35–0.44).

FIRST INSTAR (in alcohol, N = 10) (Fig. 5). Body elongate-pyriform; less dorsoventrally flattened than later instars. Coloration similar to second instar.

Length: 1.31 mm (range 0.95–1.57). Pronotal length: 0.14 mm (range 0.11–0.18). Basal pronotal width: 0.39 mm (range 0.36–0.42). Outer ocular width: 0.43 mm (range 0.41–0.45). Interocular width: 0.30 mm (range 0.29–0.33). Antennal length, I: 0.14 mm (range 0.13–0.15); II: 0.26 mm (range 0.24–0.29); III: 0.25 mm (range 0.24–0.27); IV: 0.37 mm (range 0.35–0.39).

ACKNOWLEDGMENTS

We thank G. L. Miller (Department of Entomology, Auburn University) for help in rearing *R. tigrinus* and J. F. Stimmel (BPI, PDA) for laboratory assistance.

LITERATURE CITED

- Ahmad, I. 1980. Insect fauna of Pakistan and Azad Kashmir—some groups within the order Hemiptera. Proc. 1st Pakistan Congr. Zool., pp. 115–155.
- Cobben, R. H. 1968. Evolutionary trends in Heteroptera. Part I. Eggs, architecture of the shell, gross embryology and eclosion. Centre for Agricultural Publishing and Documentation, Wageningen, 475 pp.
- Dupuis, C. 1953. Les Rhopalidae de la faune Francaise (Hemiptera Heteroptera). Cah. Nat. Bull. n.s. 8:67–82.
- Fox, L. R. and P. A. Morrow. 1981. Specialization: species property or local phenomenon? Science 211:887–893.
- Göllner-Scheiding, U. 1978. Bemerkungen zu der Gattung *Rhopalus* Schilling einschliesslich *Brachycarenum* Fieber (Heteroptera, Rhopalidae). Mitt. Zool. Mus. Berl. 54:313–331.
- Göllner-Scheiding, U. 1983. General-Katalog der Familie Rhopalidae (Heteroptera). Mitt. Zool. Mus. Berl. 59:37–189.
- Gulde, J. 1921. Die Wanzen (Hemiptera-Heteroptera) der Umgebung von Frankfurt a. M. und des Mainzer Beckens. Abh. Senckenb. Naturforsch. Ges. 37:327–503.
- Hoebeke, E. R. 1977. (Note). In: U.S. Dept. Agric., Coop. Plant Pest Rep. 2(40):802.
- Hoebeke, E. R. and A. G. Wheeler, Jr. 1982. *Rhopalus (Brachycarenum) tigrinus*, recently established in North America, with a key to the genera and species of Rhopalidae in eastern North America (Hemiptera: Heteroptera). Proc. Entomol. Soc. Wash. 84:213–224.
- Kerzhner, I. M. 1967. Order Hemiptera (Heteroptera). Pages 851–1118 in: G. Ya. Bei-Beinko (ed.), Keys to the Insects of the European USSR, Vol. 1. [Translated from Russian. Israel Program for Scientific Translations, Jerusalem.]
- Kiritchenko, A. N. 1951. Nests of birds as a biotope of the true Hemiptera [in Russian]. Entomol. Obozr., Moscow 30:239–241.
- Lipa, J. J., A. Studzinski and D. Malachowska. 1977. Insects and Mites Associated with Cultivated and Weedy Cruciferous Plants (Cruciferae) in Poland and Central Europe. Polish Scientific Publishers, Warsaw. 353 pp.
- Paskewitz, S. M. and J. E. McPherson. 1983. Life history and laboratory rearing of *Arhyssus lateralis* (Hemiptera: Rhopalidae) with descriptions of immature stages. Ann. Entomol. Soc. Amer. 76:477–482.
- Popov, Y. A. 1965. Towards the knowledge of the terrestrial Hemiptera fauna of the southern regions of the western Tien-Shan (USSR, mid-Asia). Acta Entomol. Mus. Natl. Pragae 36:169–292.
- Puchkov, V. G. and L. V. Puchkova. 1956. A key to the eggs and larvae of Hemiptera-Heteroptera injurious to crops [in Russian]. Tr. Vses. Entomol. Obsch. 45:218–342.
- Schaefer, C. W. and N. P. Chopra. 1982. Cladistic analysis of the Rhopalidae, with a list of food plants. Ann. Entomol. Soc. Amer. 75:224–233.

- Schaefer, C. W. and P. L. Mitchell. 1983. Food plants of the Coreoidea (Hemiptera: Heteroptera). *Ann. Entomol. Soc. Amer.* 76: 591-615.
- Southwood, T. R. E. 1956. The structure of the eggs of the terrestrial Heteroptera and its relationship to the classification of the group. *Trans. R. Entomol. Soc. Lond.* 108:163-221.
- Stichel, W. 1960. Pentatomomorpha, Coreoidea: Corizidae; Pentatomoidea: Pentatomidae, Scutellerinae, vol. 4, 14 Heft. Pages 417-448 in: *Illustrierte Bestimmungstabellen der Wanzen. II. (Europa Hemiptera-Heteroptera Europae)*. Martin-Luther, Berlin-Hermisdorf.
- Stokes, H. G. 1950. Notes and description of ova of *Rhopalus subrufus* Gmel. (Hem.-Het., Coreidae). *Entomol. Mon. Mag.* 86:26-28.
- Wagner, E. 1966. Wanzen oder Heteropteren. I. Pentatomomorpha. In: *Die Tierwelt Deutschlands*, 45:1-235.
- Wheeler, A. G., Jr. 1977. Life history of *Niesthrea louisianica* (Hemiptera: Rhopalidae) on rose of Sharon in North Carolina. *Ann. Entomol. Soc. Amer.* 70:631-634.
- Wheeler, A. G., Jr. 1984. *Aufeius impressicollis* (Hemiptera: Rhopalidae): easternmost U.S. record, host plant relationships, and laboratory rearing. *J. New York Entomol. Soc.* 92: 174-178.
- Wheeler, A. G., Jr. and G. L. Miller. 1983. *Harmostes fraterculus* (Hemiptera: Rhopalidae): field history, laboratory rearing, and descriptions of immature stages. *Proc. Entomol. Soc. Wash.* 85:426-434.
- Woodward, T. E. 1952. Studies on the reproductive cycle of three species of British Heteroptera, with special reference to the overwintering stages. *Trans. R. Entomol. Soc. Lond.* 103:171-218.
- Yonke, T. R. and J. T. Medler. 1969. Description of immature stages of Coreidae. 1. *Euthochtha galeator*. *Ann. Entomol. Soc. Amer.* 62:469-473.
- Yonke, T. R. and D. L. Walker. 1970. Description of the eggs and nymphs of *Harmostes reflexulus* (Hemiptera: Rhopalidae). *Ann. Entomol. Soc. Amer.* 63:1749-1754.

Received March 15, 1988; accepted July 1, 1988.